

# Supporting environmentally sound decisions for waste management with LCT and LCA

Simone Manfredi • Rana Pant • David W. Pennington •  
Andreas Versmann

Received: 8 February 2011 / Accepted: 10 June 2011 / Published online: 1 July 2011  
© Springer-Verlag 2011

## Abstract

**Introduction** The amount of waste generated in Europe and, beyond, by our production and consumption patterns is significant. A proper waste management is essential in order to reduce detrimental environmental impacts. For the European Union, the general principles of good waste management are outlined in the Waste Framework Directive (2008/98/EC). This directive establishes a five-step hierarchy of waste management starting with the preferred option of waste prevention followed by preparing waste for reuse, recycling and other recovery with disposal (such as landfill) as the last resort.

**Methods** The European Commission encourages the use of life cycle thinking (LCT) to complement the waste hierarchy for a more environmentally sound and factual support to decision-making in waste management.

**Results** This has led to the development of a set of guidelines, tailored to the needs of different target audiences, which help apply LCT and quantitative tools such as life cycle assessment to waste management systems and strategies. The main aim of this paper is to present these guidelines, while also providing a structured overview on existing waste management criteria (e.g. the waste hierarchy), concepts and tools.

---

Responsible editor: Thomas Swarr

---

S. Manfredi (✉) • R. Pant • D. W. Pennington  
Institute for Environment and Sustainability (IES),  
Joint Research Centre (JRC),  
via E. Fermi 2749,  
21027 Ispira, Italy  
e-mail: simone.manfredi@jrc.ec.europa.eu

A. Versmann  
European Commission, Environment DG,  
Unit C2—Sustainable Production and Consumption,  
1049 Brussels, Belgium

**Keywords** Life cycle assessment • Life cycle thinking •  
Waste hierarchy • Waste management

## 1 Introduction

Environmental protection ranks high in the European public agenda. Also, the waste management sector is, therefore, expected to reduce its adverse environmental impacts. However, the increasing complexity of current waste management systems and the increasingly demanding environmental protection targets make it challenging to optimise waste management strategies and policies.

The life cycle thinking (LCT) concept and quantitative tools such as life cycle assessment (LCA) can provide an informed and science-based support to a more environmentally sustainable decision-making in waste management. This has been demonstrated in many internationally recognised studies including Pennington and Konecny (2007), Ekvall et al. (2007) and the Joint Research Centre's (JRC) report "Environmental assessment of municipal waste management scenarios: part II—detailed life cycle assessments" (2007).

To support environmentally sound decision-making in waste management, the Directorate General Environment (DG ENV; 2011) (<http://ec.europa.eu/environment/waste>) and the JRC developed a set of guidelines that build on the International Organization for Standardization (ISO) 14040 series of standards for LCA (2006) and the International Reference Life Cycle Data System (ILCD) Handbook (2010). These guidelines are tailored to the needs of different target audiences and partly focusing on specific waste streams:

- "Supporting environmentally sound decision for waste management—a technical guide to LCT and LCA for waste experts and LCA practitioners" (~200 pages);

- “Supporting environmentally sound decision for construction and demolition (C&D) waste management—a practical guide to LCT and LCA” (~60 pages); and
- “Supporting environmentally sound decision for bio-waste management—a practical guide to LCT and LCA” (~100 pages).

The guidelines provided on those documents should not be understood as imposing any obligation to, e.g. companies, to justify their waste management practises with LCT/LCA. However, these guidelines aim at providing guidance to them in case they decide to do so. It is up to the member states to take measures to encourage the implementation of the options that deliver the best overall environmental outcome in the specific national conditions.

LCT and LCA provide relevant information to support decisions towards making environmentally sound choices. This information, however, needs to be complemented with other information related to legal, economic, social and operational aspects before sound decisions can be made. Other approaches should therefore be considered for a robust support to decision-making including, e.g. cost-benefit analysis, material flow analysis, social LCA, life cycle costing and input output analysis.

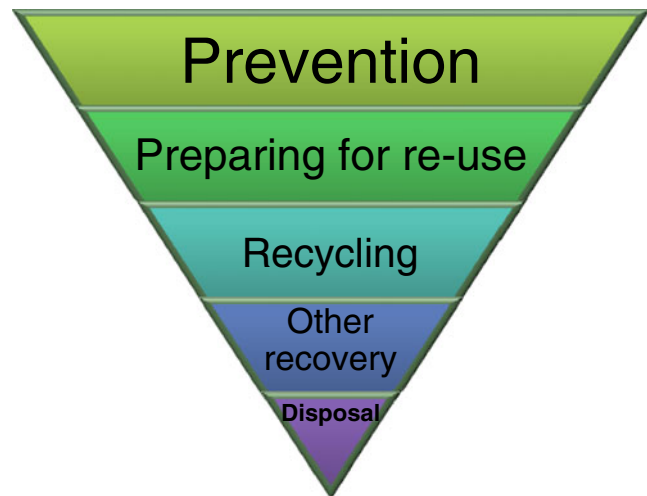
## 2 Complementing the “waste hierarchy” with LCT and LCA

### 2.1 Overview

In the area of waste management, the general principles of good management are outlined in the EU Waste Framework Directive (WFD) (2008/98/EC). In article 4(1), the WFD establishes a legally binding, five-step hierarchy of waste management, setting out an order of priorities, starting with the preferred option of waste prevention followed by preparing waste for reuse, recycling and other recovery with disposal (such as landfill) as the last resort.

In many cases, following the waste hierarchy will lead to waste being dealt with in the most resource-efficient and environmentally sound way. However, in specific circumstances and for specific waste streams, there may be a need to deviate from the hierarchy in order to select the best solution for the environment. Also, in many cases, a number of alternatives exists at a given level of the waste hierarchy (e.g. different recycling alternatives for a given waste stream). These alternatives, however, are often very different from an environmental perspective (Fig. 1).

As stated in article 4(2) of the WFD, member states have to “take measures to encourage the options that deliver the best overall environmental outcome. This may require specific waste streams departing from the hierarchy where



**Fig. 1** Waste hierarchy as supported by the Waste Framework Directive (2008/98/EC)

this is justified by life cycle thinking on the overall impacts of the generation and management of such waste”.

### 2.2 Guidelines to waste experts and LCA practitioners

This guide provides waste experts and LCA practitioners with more detailed technical guidance on how LCT and LCA can be used to identify the environmentally preferable waste management options among alternatives. It further expands the ISO 14040 series (2006) and the ILCD handbook provisions.

In particular, the document provides guidance on how to:

- Gain a good understanding of the problem and assess whether LCT and LCA can help address the issue;
- Develop and use straightforward, LCT-based criteria to address waste management issues in simple, day-to-day decision-making;
- Develop simplified, user-friendly LCA software tools for users who may not have a strong background on LCA;
- Apply LCA to support decision-making;
- Develop waste-type specific management planning to ensure consistent and robust implementation of LCT and LCA in waste management;
- Identify key indicators for waste, relevant waste treatment technologies and management options, and group waste types based on their characteristics.

### 2.3 Waste-type specific guidelines

Based on the general technical guidelines for waste experts and LCA practitioners, two waste-type specific guidelines are being developed, respectively for bio-waste and C&D waste. These translate the general guidance provided by the

technical “Guide to life cycle thinking and assessment in waste management for waste experts and LCA practitioners” into a more practical guidance on how to use LCT and LCA to support environmentally sound decision-making for the two target waste streams.

With respect to the guidelines on bio-waste, a detailed guidance is given in particular on how to recognise whether bio-waste prevention leads to environmental benefits and on how to derive and use straightforward, LCT-based criteria to identify the preferable management options among, e.g. composting, anaerobic digestion and incineration. The guidelines on C&D waste help in selecting environmentally sound options for C&D waste management and also provide an overview on reuse and recycling possibilities for valuable components in C&D waste, which an inappropriate handling may however lead to high environmental impacts.

### 3 Remarks and perspectives

The LCT concept and quantitative tools such as LCA can provide an informed and science-based support to a more environmentally sustainable decision-making in waste management. The guidelines prepared by the DG ENV and the JRC make clarity on how LCT and LCA can be applied to waste management and are tailored to the needs of different target audiences. While the main focus is on the environmental aspects, these guidelines also give general information on economic and social aspects and promote their use in the

perspective of a broader assessment of the overall sustainability of waste management systems and strategies. For more detailed information, please visit the life cycle website of the JRC (2011) (<http://lct.jrc.ec.europa.eu>) (here, continuously updated information on how to get access to these guidelines is provided) and the waste-related website of DG Environment (<http://ec.europa.eu/environment/waste>).

### References

- Directorate General (DG) (2011) Environment of the European Commission, waste-related website: <http://ec.europa.eu/environment/waste>
- Ekvall T, Assefa G, Björklund A, Eriksson O, Finnveden G (2007) What life-cycle assessment does and does not do in assessments of waste management. *Waste Manage* 27(8):989–996
- European Joint Research Centre (JRC) (2011) Institute for Environment and Sustainability (IES), life cycle website: <http://lct.jrc.ec.europa.eu>; continuously updated info on how to get access to the guidelines being developed by the JRC can be found at: <http://lct.jrc.ec.europa.eu/assessment/projects>
- European Waste Framework Directive (WFD) (2008) (Directive 2008/98/EC); available online at <http://ec.europa.eu/environment/waste/framework/>
- International Life Cycle Data System (ILCD) Handbook (2010) available online at <http://lct.jrc.ec.europa.eu/assessment/assessment/projects>
- ISO 14040 series (2006); available online at <http://www.iso.org>
- JRC (2007) Environmental assessment of municipal waste management scenarios: part II—detailed life cycle assessments. JRC scientific and technical report EUR 23021 EN/2
- Pennington D, Konecny K (2007) Life cycle thinking in waste management: summary of European Commission’s Malta 2005 workshop and pilot studies. *Waste Manage* 27(8):592–597